Constructed on a old coal mine in 2001

Alpincenter Am Tetraeder

- **One of the biggest Indoor skislopes in the world**
  - Open every day
  - 650 m long and 30 m wide
- **Approx. 10 other Indoor ski slopes in the world and several project going on.**
- **Project manager Marc Giradelli, an investment of total 50 million DM incl. restaurants**
- **Opened in January 2001, It lives about 20 million people less than an hour from the installation**
- **The refrigeration is on 1,5 MW and constructed by Axima /Grencobel in Belgium**
- **In total 55 000L of Temper –25 in 130 km of piping.**

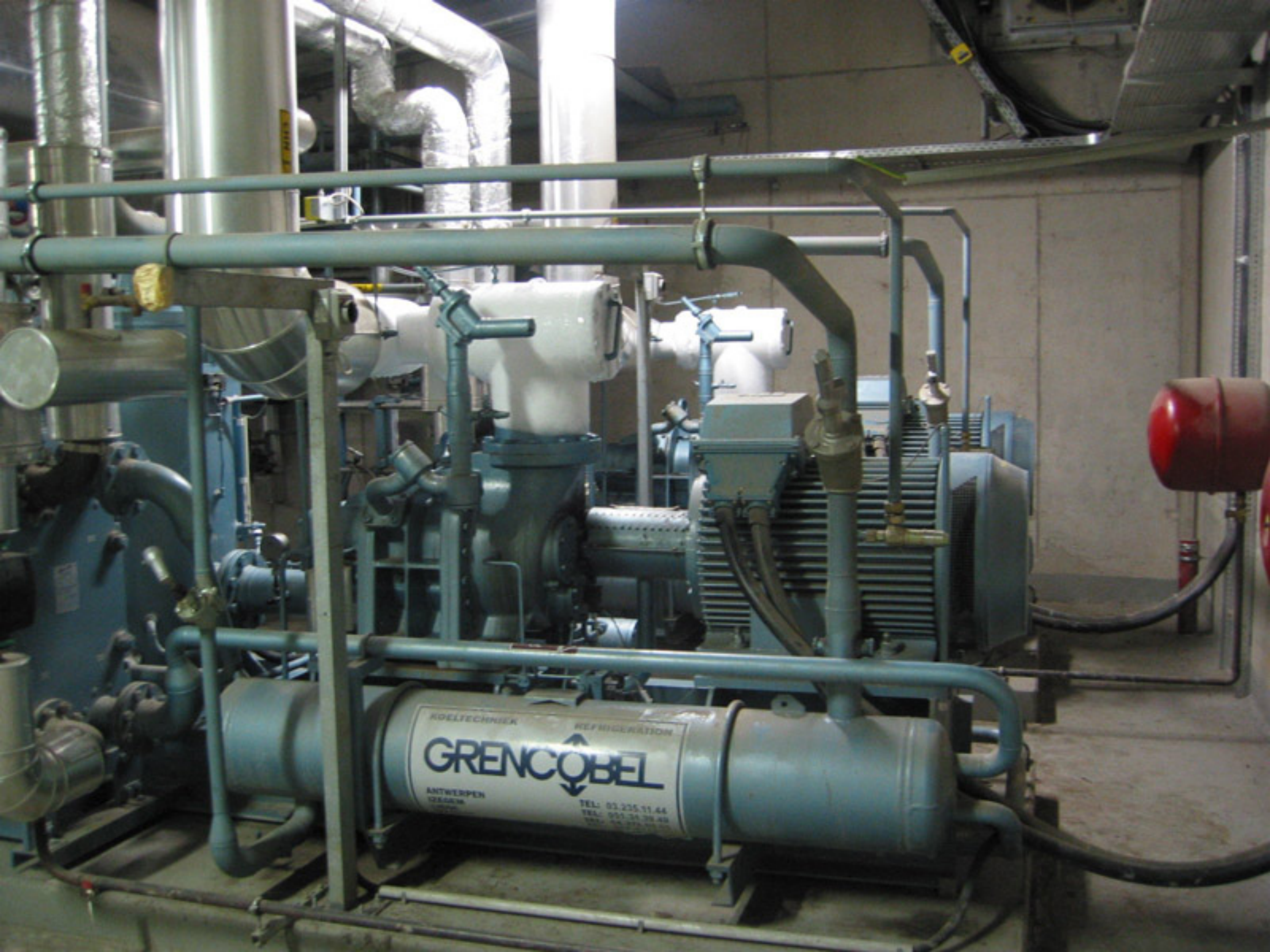
Sunpowered by
18 600 solar panels


easy living:
RWE avanza

Pictures from inside

Refrigeration

- Icemakers produce broken ice, which is broken down further and blown into the hall as snow
- The pist area is like a giant refrigerated space with a volume of more than 150 000 m3
- Waste water at 10 °C is used as underfreezing protection.
- Because Temper’s viscosity is lower than that of glycol, smaller pumps and pipes can be used.
- Reduced purchasing, installation and operating costs of the system


KOELTECHNIEK
REFRIGERATION
GRENCOBEL
ANTWERPEN
TEL: 03.235.11.44

Pumps from Grundfos

Temper snow at the World cup in Düsseldorf

For the second year in a row World cup competitions have taken place in Düsseldorf. The arrangement was a success with over 220 000 spectators during the weekend 25-26 of October.

During this period of the year there is seldom snow in Düsseldorf. So to make a course they had to use large amounts of artificial snow. Approximately 3000 cubic meters artificial snow has been produced at the in-door ski slope in Bottrop and then been transported to Düsseldorf.

Calculation sheet

Operating temperature (–15 °C)	**Temper -25**	**Ethylene glycol -25**
Density, kg/m^3	1171	1068
Dynamic viskosity, mPa.s, (cP)	7,02	11,98
Kinematic viskosity, mm^2/s, (cSt)	5,99	11,21
Specific heat, kJ/kg K	3,08	3,34
Thermal conductivity, W/m K	0,490	0,395

Calculation sheet

Operating temperature (–15 °C)	Temper -25	Ethylene glycol-25
Length, m	1	1
Diameter, m	0,016	0,016
Flow velocity, m/s	1	1 (1,73)
Heat transfer coefficient, W/m . K	1371	607 **(1371)**
Pressure drop, kPa	1,39	1,50 (3,85)

Comments to the comparison of "Thermophysical properties of liquid secondary refrigerants".

- **The comparison is for circular tubes at the given conditions regarding freezing point, operation temperature, tube diameter, tube length and flow velocity.**
- **Temper-25 at the specific conditions gives a heat transfer coefficient of 1371 W/m·°C MEG (Ethyleneglycol, monoethyleneglycol) (41% solution) with freezing point of –25°C and the same conditions gives a heat transfer coefficient of only 607 W/m^2·°C (1 m tube length) or 131 W/m^2·°C (100 m tube length).**
- **To enjoy the same heat transfer coefficient (1371 W/m^2·°C,) as for Temper at 1 m/s, you have to increase the flow velocity of the MEG from 1 m/s to 1,73 m/s. But at the same time the pressure drop for the MEG rises from 1,50 kPa to 3,85 kPa (1 m tube length) or 150 kPa to 385 kPa (100 m tube length).**
- **For MPG (Propyleneglycol, monopropyleneglycol) the figures would be 5 kPa to 30 kPa and 500 kPa to 3000 kPa or 20 times as for the Temper case to obtain the same heat transfer coefficient. The extra pressure drop cost energy.**
- **For Temper the pressure drop is only just a third of pressure drop for MEG. For Temper turbulent flow is obtained at 10°C lower than for MEG. For Temper turbulent flow is obtained at 70% lower flow velocity than for MEG. Turbulent flow allows better heat transfer**
- **The increased flow velocity for MEG includes higher costs for pumping and sometimes also for the pumps themselves due to larger pumps.**
- **Increasing flow velocity have an affect of the risk of erosion and in some cases also influence the static pressure with risk of vacuum at vulnerable spots.**

- Pressure drop and heat transfer coefficient calculations

Reynolds number, $Re = w \cdot d / n$ Nusselt number, $Nu = h \cdot d / k$ Prandtl number, $Pr = \mu \cdot c_p / k$

Laminar flow (Re < 2300)

$\Delta P_{lam} = 32 \cdot \mu \cdot w \cdot L / d^2$

$Nu_{lam} = 1{,}86 \cdot (Re \cdot Pr \cdot d/L)^{1/3}$

Turbulent flow (Re > 2300)

$\Delta P_{turb} = 0{,}092 \cdot \rho \cdot \nu^{0,2} \cdot w^{1,8} \cdot L / d^{1,2}$

$Nu_{turb} = 0{,}023 \cdot Re^{0,8} \cdot Pr^{1/3}$